CLAIMS: I CLAIM:

1. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

maintaining a source of an alternating current radio frequency signal at a radio frequency not greater than 300 MHz, said source being connected to a pair of electrodes on opposite sides of a product treatment zone to cause an radio frequency signal to generate an alternating current electric field in said medium residing within said product treatment zone;

a frequency controller to adjust said frequency of said radio frequency signal between different said radio frequencies;

a mathematical model that predicts impedance of said medium as a function of temperature;

an impedance sensor to sense impedance data of said medium; and

a computer programmed to receive said impedance data from said impedance sensor, to process said impedance data using said mathematical model for said medium, and to apply a control signal to said frequency controller to adjust said frequency of said radio frequency signal to match said sensed impedance to a predetermined impedance.

2. The apparatus of claim 1 wherein the source of said alternating current radio frequency signal includes a frequency generator connected to a power amplifier.

3. The apparatus of claim 2 further comprising an impedance matching network tunable to match the output impedance of said power amplifier to impedance of a load comprising said pair of electrodes and any said medium in said product treatment zone between said two electrodes.

4. The apparatus of claim 1 further comprising a directional coupler coupled to a transmission line leading from said power amplifier to receive signals proportional to levels of power supplied from said amplifier.

5. The apparatus of claim 4 wherein the directional coupler includes a forward power portion that receives signals proportional to the power supplied by the amplifier and a reverse power portion that receives signals proportional to power reflected back to the amplifier.

6. The apparatus of claim 5 comprising a measurement instrument connected to receive said respective signals from said forward and reverse power portions.

7. The apparatus of claim 6 wherein said measurement instrument computes a voltage standing wave ratio.

8. The apparatus of claim 7 wherein said measurement device computes a load reflection coefficient.

9. The apparatus of claim 6, wherein said computer is connected to and receives input signals from said measurement instrument, and said received input signals are processed with said temperature data in generating said control signals.

10. The apparatus of claim 1 wherein the said treatment zone is within a pipe.

11. The apparatus of claim 1 wherein said medium is a slurry.

12. A capacitive radio frequency dielectric heating apparatus for a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

a source of an alternating current radio frequency signal at a frequency not greater than 300 MHz;

a first electrode that is connected to said source; a second electrode that is connected to said source and that is spaced from said first electrode so that a product treatment zone is defined between said electrodes and said radio frequency signal flows through said medium located within said product treatment zone; and

impedance matching means for matching an impedance of said medium being heated to a predetermined constant by adjusting said frequency of said radio frequency signal.

13. The apparatus of claim 12 wherein each of said first and second electrodes have multiple electrode elements which are electrically isolated from one another, individual elements of said first electrode being located opposite corresponding individual elements of said second electrode to provide multiple pairs of opposed electrode elements.

14. The apparatus of claim 12 wherein a computer-controlled switch is connected in said radio frequency signal supply circuit for each pair of electrodes so that individual electrode pairs can be turned off and on by said computer.

15. The apparatus of claim 12 further comprising temperature sensors, and wherein at least some of the temperature sensors are supported on the first electrode.

16. The apparatus of claim 12 wherein the said treatment zone is within a pipe.

17. The apparatus of claim 12 wherein said medium is a slurry.

18. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

at least one pair of spaced-apart electrodes defining a heat treatment zone for heating said medium;

signal generating circuitry connected to said electrodes, said signal generating circuitry being capable of providing an alternating current radio frequency signal to charge said electrodes and generate an alternating current electric field in said heat treatment zone;

impedance measuring circuitry connected to said electrodes and to said signal generating circuitry, said impedance measuring circuitry measuring an impedance of said electrodes and at least one chemical composition within said medium located in said treatment zone; and

a controller linked to said impedance measuring circuitry and said signal generating circuitry, said controller controlling said signal generating circuitry and said alternating current electric field generated thereby based on said impedance measured by said impedance measuring circuitry.

19. The apparatus of claim 18 wherein said signal generating circuitry includes a variable frequency radio frequency signal generator.

20. The apparatus of claim 18 wherein said signal generating circuitry includes an amplifier connected to said variable frequency radio frequency signal

generator.

21. The apparatus of claim 18 wherein the said treatment zone is within a pipe.

22. The apparatus of claim 18 wherein said medium is a slurry.

23. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

a source of an alternating current radio frequency signal at a radio frequency not greater than 300 MHz, said source being connected to a pair of electrodes on opposite sides of a product treatment zone to cause said radio frequency signal to flow through said product treatment zone;

a frequency controller to adjust said radio frequency of said radio frequency signal between different radio frequency frequencies;

a mathematical model that predicts Debye resonance frequency as a function of temperature for said medium to be heated by said apparatus;

a temperature sensor to measure temperature data of a said medium located in said zone; and

a computer programmed to receive said temperature data from said temperature sensor, to process said temperature data using said mathematical model for said medium, and to apply a control signal to said frequency controller to adjust said frequency of said radio frequency signal to a Debye resonance frequency of said product at said sensed temperature in said zone.

24. The apparatus of claim 23 wherein said mathematical model provides Debye

resonance frequency information for at least one chemical composition within said medium; and said apparatus further comprises an input device that communicates to said computer what type of said medium is located in said zone.

25. The apparatus of claim 23 wherein said input device communicates to said computer what type of said medium is located in said zone.

26. The apparatus of claim 23 wherein said mathematical model is a data table that contains Debye resonance frequencies for at least one chemical composition within saidmedium at various temperatures.

27. The apparatus of claim 23 wherein said mathematical model predicts the Debye resonance frequencies for at least one chemical composition residing in said medium based on dielectric properties of said chemical composition.

28. The apparatus of claim 23 further comprising a field strength controller that responds to signals from the computer to adjust the power level of the radio frequency signal in the zone.

29. The apparatus of claim 23 wherein said mathematical model provides Debye resonance frequency information for at least one chemical composition residing in said medium;

said apparatus further comprises an input device that communicates to said computer whether said medium is in contact with a chemical composition that can function as a carrier medium of said frequency to at least one said chemical composition targeted for heating, and

said computer being programmed to signal said frequency controller to adjust said frequency of said radio frequency signal to a frequency that is not a

Debye resonance frequency of said carrier medium

30. The apparatus of claim 23 wherein the said treatment zone is within a pipe.

31. The apparatus of claim 23 wherein said medium is a slurry.

32. A capacitive radio frequency dielectric heating apparatus for heating a medium, said medium comprising hydrocarbonaceous material selected from the group consisting of oil shale, tar sand, oil sand, coal, bitumen, and/ or kerogen, the apparatus comprising:

a source of an alternating current radio frequency signal at a frequency not greater than 300 MHz;

a first electrode that is connected to said source; a second electrode that is connected to said source and is spaced from said first electrode so that a treatment zone is defined between said first and second electrodes and a radio frequency signal flows through said medium in said treatment zone;

multiple temperature sensors positioned to measure temperature data at multiple regions of said medium located in said zone; and

a computer which receives temperature data from said temperature sensors, processes said temperature data using a mathematical model for said medium, and adjusts at least one characteristic of said radio frequency signal in response to changes in said sensed temperatures in said zone.

33. The apparatus of claim 32 wherein each of said first and second electrodes have multiple electrode elements which are electrically isolated from one another, individual elements of said first electrode being located opposite corresponding individual elements of said second electrode to provide

multiple pairs of opposed electrode elements.

34. The apparatus of claim 32 wherein a computer-controlled switch is connected to said radio frequency signal supply circuit for each pair of said electrodes so that individual said electrode pairs can be turned off and on by said computer.

35. The apparatus of claim 32 wherein at least some of said temperature sensors are supported on said first electrode.

36. The apparatus of claim 32 wherein the said treatment zone is within a pipe.

37. The apparatus of claim 36 wherein said medium is a slurry.